

CLAIMS

WHAT IS CLAIMED IS:

1. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to laser powder fusion welding, the system comprising:
 - a laser head system;
 - a linear displacement element coupled to the laser head and enabling the laser head to be displaced linearly in a first dimension; and
 - a support apparatus capable of holding the workpiece adjacent the laser head in an adjustable and selectable manner, the support apparatus providing five degrees of freedom in second and third linear dimensions and first, second, and third rotational dimensions; whereby
 - the laser head may engage the workpiece about an exterior of the workpiece.
2. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to laser powder fusion welding as set forth in Claim 1, wherein the laser head system further comprises:
 - a laser welding head.
3. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to laser powder fusion welding as set forth in Claim 1, wherein the laser head system further comprises:
 - a powder feed delivery system.
4. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to laser powder fusion welding as set forth in Claim 1, wherein the laser head system further comprises:
 - a tracing system determining topology of a workpiece.
5. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to laser powder fusion welding as set forth in Claim 1, wherein the tracing system further comprises:
 - a laser rangefinder.

6. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding as set forth in Claim 1, wherein the support apparatus further
comprises:
4 an x-axis prismatic element enabling linear travel along a first linear axis;
6 a y-axis prismatic element enabling linear travel along a second linear axis;
8 a roll revolute element enabling angular travel centered upon a roll axis;
a pitch revolute element enabling angular travel centered upon a pitch axis;
and
10 a yaw revolute element enabling angular travel centered upon a yaw axis;
the x-axis, y-axis, roll revolute element, pitch revolute element, and yaw
revolute elements coupled to one another.
7. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding as set forth in Claim 1, further comprising:
4 a filler delivery system providing filler material to the laser head system;
6 a laser supplying laser light to the laser head system; and
a controller system controlling operation of the filler delivery system, the
laser, the laser head system, the linear displacement element, and the support
apparatus.
8. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding as set forth in Claim 7, wherein the laser further
comprises a laser selected from the group consisting of:
4 an Nd-YAG laser;
6 a CO₂ laser; and
an ytterbium fiber diode laser system.
9. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding as set forth in Claim 7, wherein the controller system further
comprises:
4 a digital servo amplifier system coupled to the support apparatus and
controlling operation of the five degrees of freedom.
10. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to

2 laser powder fusion welding as set forth in Claim 7, wherein the controller system further
comprises:

4 a robot controller coupled to and controlling the laser head system, the linear
displacement element, and the support apparatus.

11. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding as set forth in Claim 7, wherein the controller system further
comprises:

4 a computer programmably operating the controller system and enabling
recording of data through the controller system.

12. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding, the system comprising:

4 a laser head system including a laser welding head, a powder feed delivery
system, and a tracing system determining topology of a workpiece;

6 a linear displacement element coupled to the laser head and enabling the laser
head to be displaced linearly in a first dimension; and

8 a support apparatus capable of holding the workpiece adjacent the laser head
in an adjustable and selectable manner, the support apparatus providing five degrees
10 of freedom in second and third linear dimensions and first, second, and third
rotational dimensions, the support apparatus including an x-axis prismatic element
enabling linear travel along a first linear axis, a y-axis prismatic element enabling
12 linear travel along a second linear axis, a roll revolute element enabling angular
travel centered upon a roll axis, a pitch revolute element enabling angular travel
14 centered upon a pitch axis, a yaw revolute element enabling angular travel centered
upon a yaw axis, the x-axis, y-axis, roll revolute element, pitch revolute element,
16 and yaw revolute elements coupled to one another;

18 a filler delivery system providing filler material to the laser head system;

20 a laser supplying laser light to the laser head system, the laser including a
laser selected from the group consisting of:

22 an Nd-YAG laser;

 a CO₂ laser; and

 an ytterbium fiber diode laser system; and

24 a controller system controlling operation of the filler delivery system, the
laser, the laser head system, the linear displacement element, and the support
26 apparatus, the controller system including:

28 a digital servo amplifier system coupled to the support apparatus and
controlling operation of the five degrees of freedom;

30 a robot controller coupled to and controlling the laser head system, the
linear displacement element, and the digital servo amplifier; and

32 a computer programmably operating the robot controller and enabling
recording of data through the controller system; whereby
the laser head may engage the workpiece about an exterior of the workpiece.

13. A 3-D adaptive laser powder fusion welding system for subjecting a workpiece to
2 laser powder fusion welding as set forth in Claim 12, wherein the tracing system further
comprises:

4 a laser rangefinder.